INCUMBENCY, TRUST AND THE MONSANTO EFFECT: STAKEHOLDER DISCOURSES ON GREENHOUSE GAS REMOVAL

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ABSTRACT

This paper explores factors shaping perceptions of Greenhouse Gas Removal (GGR) amongst a range of informed stakeholders, with a particular focus on their role in future social and political systems. We find considerable ambivalence regarding the role of climate targets and incumbent interests in relation to GGR. Our results suggest that GGR is symbolic of a fundamental debate – occurring not only between separate people, but sometimes within the minds of individuals themselves – over whether technological solutions represent a pragmatic or an unethical strategy. We present the idea of

a ‘Monsanto effect’, whereby an entirely separate debate taps into deeper narratives and becomes so pervasive that it spills over into a new topic area. Our findings have significant implications for extant and emergent climate policy as they suggest that, in addition to the considerable practical challenges facing large-scale GGR deployment, there is a deeper psychological challenge in that actors are themselves conflicted about the fundamental desirability of GGR.

KEYWORDS

climate change; greenhouse gas removal; negative emissions technologies; perceptions

1. INTRODUCTION

The idea of Greenhouse Gas Removal (GGR) has risen rapidly up the academic and policy agenda in recent years. It has increasingly been suggested that, in order to meet ambitious global climate change targets, there is a need not only to reduce the emission of greenhouse gases (GHGs) but to actually remove previously emitted GHGs from the atmosphere in order to compensate for difficult-to-decarbonise sectors such as heavy industry and aviation (EASAC 2018). This question has become even more pressing since the adoption of the Paris Agreement in 2015, Article 2 of which states the aim to pursue efforts to limit the global temperature increase to 1.5°C above pre-industrial levels (United Nations 2015). The majority of Integrated Assessment Model (IAM) scenarios used by the Intergovernmental Panel on Climate Change (IPCC) require GGRs at a significant scale to meet even a two degrees Celsius (°C) target – a fact that was only recently brought to the fore via increased scrutiny of modelling assumptions following the Paris Agreement (Anderson and Peters 2016). Since then, a diverse range of GGR approaches have been proposed; some of the major ones under consideration are explained in Table 1 (below).

Much existing social science research addresses the topics of ‘geoengineering’, defined as ‘the deliberate, large-scale manipulation of the planetary environment in order to counteract anthropogenic climate change’ (Royal Society 2009, 1). This field generally distinguishes between Solar Radiation Management (SRM) measures, which would alter the Earth’s albedo, and GGR measures that aim to remove GHGs from the atmosphere. Most of the research on geoengineering to date focuses on SRM (Cummings et al. 2017), but there is a fast-growing body of technical work on GGR as well as several papers questioning the assumptions of large-scale GGR in many policy-relevant climate models (see Anderson and Peters 2016; Larkin et al. 2017; Vaughan and Gough 2016).

Research has also identified multiple ethical concerns associated with GGR, which means that deploying it at scale to meet emissions targets is not a foregone conclusion (Cox et al. 2018). Christopher Preston (2013) reviews thirteen topics of ethical concern relating to GGR and SRM that emerge within four temporal spaces (pre-research, research and development, implementation and post-implementation), focusing particularly on the 'moral permissibility' of intentionally altering the climate. A number of papers discuss various other ethical issues, including: concerns about the justice implications of GGR for vulnerable populations, low-emitting countries and future generations (Hansen et al. 2017; Lawford-Smith and Currie 2017); concerns about democracy and plurality in decision-making (McLaren 2016; Porter and Hulme 2013); and concerns that GGR might reduce support for ambitious emissions reductions (Campbell-Arvai et al. 2017; Markusson et al. 2018). Sam Adelman (2017) argues that, although it is important to distinguish between GGR and SRM, both are risky in terms of the ethics of human rights, for reasons of scientific hubris, cessation concerns and technological 'fetishism' (i.e. the mistaken belief that technology is the answer to all problems). Yet Preston (2015) suggests that GGR is less ethically problematic that SRM because it is 'restorative' as opposed to 'additive': it reduces anthropogenic forcing to levels more consistent with an earlier time. Similarly, much of the scientific literature argues that GGR (unlike SRM) treats the root *cause* of the problem rather than the 'symptoms' (Minx et al. 2018). Nevertheless, this characterisation of GGR has been shown to be dependent on whether the 'cause' of climate change is defined as the greenhouse gases themselves, or the irresponsible burning of fossil fuels (Cox et al. 2018).

1.1 Stakeholder discourses on geoengineering, GGR and climate change

Many aspects of climate change are characterised by deep, often irreducible uncertainty. This has led to a growing use of 'expert elicitation' methods, which seek to gather the informed opinions of expert stakeholders operating in specific domains, in order to develop systematic knowledge about problems that involve significant uncertainty (Rai 2013). Such methods have been used extensively in quantitative decision-making processes, including interrogating the role of GGRs in climate models (Vaughan and Gough 2016). Since expert stakeholders are increasingly called upon to inform such decision-making processes, it is important to understand their perspectives and discourses, especially in instances of high uncertainty or novelty (Lowe and Lorenzoni 2007). Importantly, expert perceptions are informed by values and beliefs as well as by scientific information and analysis: topics such as climate change are understood in diverse ways, meaning that 'knowledge' (even that

of the most eminent experts) depends on numerous contextual factors, including individuals' values and belief structures (Hulme 2009). One advantage of expert elicitation is that it can help to understand the complex underlying factors and discourses that currently shape stakeholders' perceptions, thus illuminating some of the knowledge forms and subjectivities that may feed into decision-making processes.

There is an existing body of scholarly work on stakeholder discourses in the context of geoengineering. This tends to fall into two analytical categories: examinations of discourses in the public sphere (for instance, in print media or policy documents), and face-to-face studies using workshops, interviews or online methods. Within the former, Brigitte Nerlich and Rusi Jaspal (2012) conduct a metaphor analysis of framings of geoengineering in news and magazine articles from 1985 to 2010, finding three overarching metaphors: 'the planet is a body', 'the planet is a machine' and 'the planet is a patient/addict'. Similarly, Kate Porter and Mike Hulme (2013) argue that print media anthropomorphises the earth when discussing geoengineering, particularly seeing as it does not generally distinguish between SRM and GGR. Jonas Anshelm and Anders Hansson (2014) also analyse media discourses on geoengineering, comparing an 'advocacy' discourse to a 'critical' one and finding a fundamental dissensus between the two; notably, they argue that this relates to the different ways in which the discourses present views on social change, knowledge and humanity's ability (or lack thereof) to control or manipulate nature. Finally, Duncan McLaren (2016) undertakes a secondary analysis of a corpus of media content studies (including those mentioned above), finding three explicit 'master framings' – technological optimism, political realism and catastrophe avoidance. Interestingly, McLaren also finds that justice is notable by virtue of its absence in these framings, with related concepts such as equity, fairness and distribution receiving barely any mentions. As such, he argues that geoengineering media discourse has deliberately 'framed out' justice, particularly in the ways in which geoengineering is positioned as 'essential' in the face of unmitigated climate change.

A related but separate body of work elicits stakeholder opinions on geoengineering using face-to-face methods. Reviewing the existing research on stakeholder discourses with the goal of illuminating factors that may influence public attitudes, Adam Corner et al. (2012) found a wide range of overlapping and conflicting views within a rather limited literature. Part of the aim of the present paper is to explore the reasons *why* these views might be overlapping and conflicting. In a Q-methodology study on geoengineering, Rose Cairns and Andy Stirling (2014) found four dominant framings and an apparent polarisation of the discussion. However, within the alternative framings proposed, they found that a more nuanced picture emerged, with the ambiguity of the term 'geoengineering' being used to provide flexibility for diverse interests. Meanwhile, Rob Bellamy et

al. (2013) conducted a large multi-criteria mapping study wherein experts (and publics, in a parallel series of workshops) drew up set of criteria by which to judge geoengineering proposals, comparing a number of specific geoengineering options with alternative mitigation options. Accordingly, the authors suggested 'opening up' the discussion to a wider range of criteria and perspectives – an aim that is purposefully reflected in our methodology (see section 2). Finally, in one of the only existing studies on a specific GGR technique, Kate Gannon and Mike Hulme (2018) use Q-methodology to study communities affected by a highly controversial ocean fertilisation project. Their findings suggest that perspectives were strongly geographically rooted, yet also connected to wider cultural meanings and discourses regarding human values of and responsibilities toward nature, demonstrating that participants discourses 'reflect the contested philosophical underpinnings of wider environmental management and restoration debates' (ibid., 14). It is worth pointing out the particularities of ocean fertilisation as a GGR, however, since deployment takes place in open oceans and therefore, unlike most GGRs, its effects are territorially unbounded. Nevertheless, these polarised discourses around mankind's relationship with the natural world may still be relevant for thinking about more spatially constrained GGRs in future.

Much of the previous research on stakeholder discourses examines 'geoengineering' as an umbrella term. Yet this term is broad and ambiguous, encompassing as it does a huge diversity of approaches and concepts with vastly different implications. For these reasons, Dale Jamieson (2013) argues that geoengineering 'does not mark a specific category of response to climate change but simply alerts us to the fact that the approach under discussion is viewed by the speaker as novel, weird, exotic, unfamiliar, or untested' (529). There is also increasing recognition that the issues faced by GGR may in fact be quite different from those faced by SRM and that the two should therefore be disentangled (Cox et al. 2018; Heyward 2013). Different approaches may also entail different forms of sociotechnical governance. Ocean fertilisation provides one example of this, with deployment being prohibited under international law because of the unbounded and unpredictable nature of its effects. There is value, therefore, in focusing the enquiry by looking at discourses on a set of specific GGR proposals.

[Table 1]

1.2 Methods

This study forms the initial part of a larger, ongoing project on attitudes toward GGR, with a particular focus on three novel 'engineered' GGRs envisaged for deployment at significant scale: Direct Air Capture, Enhanced Rock Weathering and Bioenergy with Carbon Capture and Storage (BECCS). We focus on these three proposals because, at present, these appear to be the three with the greatest long-term CO2 sequestration potential (see Minx et al. 2018, Fig. 6), and thus represent important considerations for decision makers. For this initial stage of the project, we conducted semi-structured interviews with seventeen informed stakeholders, with the aim of exploring what factors and underlying discourses currently shape their perceptions. Appraisals of technically advanced climate strategies can suffer from a tendency to 'close down' around narrow problem definitions (see Bellamy et al. 2013); we aim to overcome this by setting up a semi-structured format in which the interviewee is largely allowed to determine the direction of the conversation, thereby opening up to a wider diversity of framings. As such, the results should not be considered 'representative' of the full opinions of any individual participant – or the body of participants as a whole – but rather as offering in-depth insight into some of the more complex and nuanced aspects of this topic. Despite focusing initially on specific GGR proposals, the semi-structured methodology meant that participants often volunteered their own understandings of 'GGR' – for instance, by discussing other proposals or by talking more generally about the concept of removing GHGs from the atmosphere.

For brevity, we henceforth refer to our participants as 'experts'. However, it is worth noting that terms such as 'experts' and 'informed stakeholders' are complex, and there is no agreed definition of what constitutes an 'expert' (Lowe and Lorenzoni 2007). Expertise takes many forms, and some of our participants were selected for their broader knowledge of related fields as opposed to specific expertise on the any of the three GGR proposals. Accordingly, it is important to avoid fetishising 'expert' knowledge, as this may not be any more valid or insightful than that of people approaching the topic of GGR for the very first time. We therefore conceptualise our 'experts' more as a representation of a particular 'type' of public (or rather, several types, considering their range of expertise) who seemed likely to have some interesting *pre-existing* opinions on GGR.[1]

Our selection of interviewees was designed to elicit a broad range of expertise. We first identified a set of five relevant sectors that we thought would give us a range of perspectives: academia (physical sciences, engineering); academia (social sciences, law); policy and regulation; non-governmental organisations (NGOs); and the industrial/private sector. Previous work has shown that the sector in which people work has an influence on their perspectives (Allison 1969); a sectoral

[1] Later in the project, the results of this study will be used for triangulation with results from workshops with lay publics wherein we expect much lower (possibly non-existent) levels of pre-existing knowledge.

approach like ours is thus one way of targeting and accessing a broader spectrum of views. Within these sectors and specialisms, our respondents were selected on the basis of purposive sampling, wherein we first contacted people who we were aware would have pre-existing knowledge and opinions on GGR, either because of their job role or because of their public or research profile. In some cases, we failed to attract a response from the desired individual, and therefore decided to use snowball sampling by asking participants to suggest additional people. This combination of purposive and snowball sampling is suitable for instances where the researchers have knowledge of the individuals working within the field, and for studies aiming toward depth and nuance rather than statistical representativeness.

Table 2 details the sector and subject area of each of our participants. To uphold confidentiality, we avoid providing identifying information and, for the results section, we have assigned random alphabetical aliases which do not correspond with any characteristics of the participants. The table shows that the majority of interviewees were academics; this is partly due to a higher rate of response, and partly a reflection of the early stage of GGR development, which means that there are relatively few individuals in other sectors who we felt would have pre-existing knowledge. The people we interviewed were all from the UK and US, although they all work for international organisations or conduct international research. The topic of GGR has a global aspect, because many research efforts stem from the context of global science/policy on climate change, and our participants' expertise was generally global enough that informed discussion was had without deference to geographical context. That said, practices of GGR and their discourses are geographically rooted and tend to be embedded in local contexts, a factor which is important to take into account when interpreting the results. We found that discussions on policy and governance, for instance, tended to be place-specific and were primarily rooted in a western context.

Interview transcripts were analysed using recognised methods for thematic coding analysis (see Braun and Clarke 2006), using N-Vivo software. We began by listening carefully through the interview recordings many times, to become familiar with the data and to inductively draw out key 'themes' that were prevalent in and across the interviews. In the tradition of narrative analysis, our focus was very much on the *content* of what was said (as opposed to, say, discourse analysis where the focus is on *how* it is said), following methods for upstream elicitation described by Phil Macnaghten and Greg Myers (2004). In this paper, we focus on two key themes which emerged consistently as the focus of interview discussions – 'risk' and 'responsibility'. We also look at the 'role of the public', a theme that was deliberately introduced via direct questioning from us for triangulation with the results from our non-expert study later on. The following section addresses each of these themes in turn, presenting what was said by our participants in a descriptive manner.

Section 4 then analyses the deeper content of these responses, looking at *why* our participants might have responded in this way and what this might tell us about deeper narratives on novel GGRs.

[TABLE 2]

2. RESULTS

2.1 Risk

'Risks' or 'concerns' around GGRs emerged, as anticipated, as one of the central themes of our coding analysis. Yet one of the striking things was the sheer diversity of risks mentioned, and the diversity of conceptual approaches used to discuss various risks. For every new interviewee we spoke to, a different range of concerns emerged; importantly, however, this was not necessarily aligned with people's disciplines. For example, some of the participants with expertise in physics or modelling showed themselves to be interested in (and adept at) discussing social and ethical issues. Broadly, it is possible to differentiate between three types of risk among those mentioned: physical/environmental (e.g. land-use requirements, ecosystem impacts), techno-economic (e.g. high capital costs, lack of technology readiness) and social (e.g. acceptability, equity, health). For Direct Air Capture and Enhanced Weathering, techno-economic and environmental risks were overwhelmingly mentioned first and most explicitly, whereas social risks were mentioned more implicitly and much later in the conversation (if at all). However, when discussing Bioenergy with Carbon Capture and Storage (BECCS), no such pattern emerged – social risks were mentioned just as frequently as environmental ones. We hypothesise that this could be because of the relative state of knowledge about unintended social consequences, many of which have become apparent with the development of a large-scale biomass industry. Unintended social consequences are notoriously difficult to envisage, so social risks for more novel GGRs are perhaps under-discussed precisely because we haven't yet experienced them. For bioenergy on the other hand, it has become apparent that the social and physical risks are actually tightly interconnected: for example, impacts on ecosystem *services* constitute both an environmental and a social risk.

One of the most common 'risk' topics discussed was the concern that investing or even believing in the *prospect* of negative emissions at scale might reduce incentives to pursue steep emissions reductions – termed 'mitigation deterrence' by the GGR research team at Lancaster University (see Markusson et al. 2018). The risk of mitigation deterrence was

portrayed, not just as a question of policy, but also as a question of narratives – or, in the words of one participant, 'the stories we tell ourselves':

> So, a negative emission technology operating out of a field in Bedfordshire justifies the continued exploitation of the North Sea and fracking, because of the stories we tell ourselves, 'It's all okay because we've now got this way of dealing with the emissions as a consequence'. (Participant O)

Unsurprisingly, there was generally consensus that conventional mitigation (in the sense of low-carbon supply or energy demand reduction) should come first and foremost, and that GGR should be thought of as 'a potential addition' and 'in no way a substitute', with 'a larger role for demand reduction and more renewables' (participants B and P).[2] Yet many people also recommended GGR for maintaining a diverse portfolio of measures, whilst acknowledging that tough choices must be made regarding what this portfolio might look like and the trade-offs therein. In the words of participant G: 'I don't think any one of the proposed solutions so far is a magic bullet. We are looking at a blend of different solutions. I just think, we need to get on with it'. Most participants rejected the idea of a binary choice between mitigation and GGR, while at the same time warning of mitigation deterrence and opportunity cost; clearly, a difficult task remains in deciding what sort of portfolio of measures should exist, and who gets to decide what this should look like.

It would be remiss to discuss perceptions of risk without also discussing potential benefits, the most commonly mentioned of which was the possibility that GGR will become necessary to avoid dangerous climate change. This topic in many ways illustrates the diversity of responses: opinions ranged from 'GGRs are vital' to 'GGRs are dangerous', and everything in between. The following remark by participant C is a good example of the 'necessity' discourse:

> But we have absolutely no chance of getting there [to global net zero emissions] without carbon dioxide removal, there's no question about that. If you run the models on the back of an envelope, you don't need a computer, we're just not ever going to get there.

[2] It is worth reiterating that the mitigation scenarios used to inform policy-makers do *not* portray GGR as an 'addition'; rather, in the vast majority of models, large-scale GGR development is critical to meeting the minimum 2°C reduction target.

This stance is tightly connected to a prevalent discourse of urgency, evident in assertions such as 'we just need to get on with it'. Yet many participants argued that the modelling assumptions that led us to these conclusions need to be examined more critically. The assumption that GGR will be 'necessary' to avoid 'dangerous' climate change is clearly a strongly framed statement that is somewhat reliant on trust in the IPCC IAM scenarios – trust which may be wavering amongst the scientific community owing to concerns over the transparency of GGR assumptions in these models. This uncertainty resulted in a complex and sometimes ambivalent discourse emerging across the interviews regarding deference to global climate targets and institutions as well as the role of experts in tackling climate change. Several participants critiqued the process of target setting and the emergence of the 'necessity' discourse as having taken place within a very top-down, undemocratic system; yet many acknowledged that international agreements – and the science to back them up – may be required to deal with the problem of climate change. One comment from participant L illustrates the two sides of this discourse, in which some participants fell squarely in the middle:

> So, I'm a degree sceptical about, in the bigger picture, these targets take on too big a role in shaping and guiding and directing, not just discursively, but actual real investments. Having said that, this is the political process we're in and we've been in it for thirty years around climate change, and international negotiations and target setting is not going to disappear anytime soon.

2.1 Responsibility

Although not always mentioned explicitly, responsibility was a prevalent underlying topic during these interviews. Responsibility can of course mean many things: responsibility for emissions reductions; responsibility to develop and pay for GGRs; responsibility to govern and safeguard against risks of various kinds; responsibility to pursue equity, justice and democracy. Many of the semi-structured discussions drifted quickly onto the topic of 'who decides' on a desirable emissions target and how best to go about achieving it, a clear corollary to the discussion about deference to climate targets. Very frequently, points were made regarding how 'we' or 'society' needs to make decisions, as illustrated by this quote from participant D:

> And so, we have to make some hard choices at this point, and we need some tools in determining what those trade-offs are and how we as a society determine how we make those trade-offs.

This raises questions regarding what was meant by words such as 'we' and 'society'. Several participants mentioned the topic of democracy and collective decision-making, yet sometimes went on to focus mainly on the role of experts and policy-makers; in fact, for most participants, the subtext of 'responsibility' seemed to lie mostly with experts, policy-makers and high-emitting industries. Alongside this, however, the interviews demonstrated a rather fundamental lack of trust in policy-making and private sector institutions. For example, participant B commented: 'I think the answer has to lie with the politicians, which I wouldn't like to leave too many decisions to them'. Participant N neatly sums up the nuanced way in which this lack of trust is not necessarily based on the untrustworthiness of any particular institution or individual: 'We're not talking about conspiracies here, we're talking about the way incentives align, the way incentives are reformulated as a result of the co-development of new technologies'.

Our interviewees were similarly cautious about the role of researchers and technology developers, voicing wariness about 'advocates who see all the benefits' (participant P) and 'passionate scientists who have a very clear bias' (participant M). The private sector was also revealed as a major source of mistrust: 'I think we're all of us now rightly suspicious of the motives of large, multinational corporations' (participant C). Fundamental ambivalence was revealed about the role of the private sector in research and development for GGR, with participants lacking trust in the intentions of the private sector and in the objectivity of privately funded trials. Concerns about the full reporting of negative results were raised by several people, and multiple participants referred to past controversies over private sector involvement – particularly the Monsanto company – in genetically modified (GM) crop development (more on which in section 4). Yet, simultaneously, participants acknowledged that the resources held by the private sector may be required for capital-intensive research and technology development. For example, participant D said: 'I would have some enhanced concerns if this were being driven by a profit motive, while simultaneously acknowledging that that might be the only way that it actually happens'. Private capital will never have altruistic motives, but at the same time it was argued by many that working with powerful institutions is more pragmatic than working against them. This essentially comes down to a question of whether the ends justify the means: 'Social responsibility versus vested interest is a fine line, perhaps, but there we go' (participant G).

Related to the theme of responsibility was what we might call the 'polluter pays' principle. Participants suggested that, by working within incumbent systems, it could be possible to create climate strategies that are paid for by those responsible for the problem in the first place, i.e. the world's highest emitters. Many mentioned the idea of a tax or levy on emissions, which could be used to pay for GGR research or incentives. This was popular both for reasons of both fairness and pragmatism. 'It'd be quite good to turn the fossil industry around and say, "Now fix the problem you created"', remarked participant H, but also: 'If we get away from fossil fuels but somehow, we don't put everyone out of business … we just turn them round and do something else with it'. Participant K suggested that having GGR options (particularly Direct Air Capture) on the table could actually help to shift the burden of responsibility:

> Having a technology that could remove CO2 from the atmosphere changes the whole moral situation. At the moment, an emitter of CO2 can say, 'Well, we would clear it up if we could, but there's no technology that can do it, so we can't.' Once there is a technology that can do it, it's no longer, 'We can't do it', it's, 'We don't want to do it.' And that creates a very different moral situation. It enables people to say, 'Well, you should clean it up because you can'.

However, among many of the participants, there was also a strong feeling that an incumbent system would tend to benefit historical winners. Some participants even saw GGR as presenting an 'opt-out' for those responsible for causing the problem in the first place – an issue that is closely connected to the narratives of necessity and mitigation deterrence discussed previously. For participant Q, for example:

> Governments and politicians and others are signing up to saying, 'We're going to aim to get as close to 1.5˚ as we can or well below 2˚.' And yet, on the same hand, at the same time, knowing full well they're not actually decarbonising their own economies very far.

Several participants also pointed out that perspectives on GGR may be very different in the Global South where, as participant Q notes:

> There's a great deal of scepticism around negative emissions… many of those countries have been at the front end of western countries' dash for biofuels; it's their forests that have been bought up by overseas companies and people driven off, or the oil palm rush, or the rush to produce soya to feed our cattle so we can have massive Big Macs.

The ethics of international carbon accounting is complex and often fails to recognise the equity and justice considerations of implementing GGR in developing countries. For example, there was widespread consensus amongst participants that implementing BECCS at scale would probably result in some extremely unjust outcomes, potentially penalising vulnerable communities for the past and/or present actions of the world's wealthy and powerful. As Participant A said: 'it's bloody suspicious how often the settings in which these things are best experimented with happen to be the settings where they're least resisted'.

2.2 The role of the public

At the end of our interviews, the participants were asked directly about their thoughts on the role of the public (or, as stressed by many, the role of various publics) in GGR development and deployment. It is interesting that, despite the prevalence of topics of responsibility and power across almost all interviews, the role of non-experts did not tend to arise until the question was asked explicitly at the end of the interview.

Several participants conceptualised the role of the public in terms of policy and decision-makers, stating for example that: 'the primary role of the public is to motivate their politicians' (C) and that, 'if you're not involving members of the public in this decision, you're missing important evidence upon which to base your decisions' (B). Similarly, several suggested that the role of the public should be to provide checks and balances to the experts and proponents of GGR about whom distrust was voiced previously: 'I think sometimes when we say 'expert', we mean someone who's already got the blinkers on' (H). This response itself reveals some reflexivity around the role of experts, as this interviewee presumably recognises that they are themselves considered an 'expert'. However, some participants argued that the role of the public is more fundamental, and should take place earlier in the process, setting the very framing of the questions around these proposals: 'It's not so much how should society be involved in this question, it's more what questions does society want

to ask?' (A). This sentiment was also voiced alongside a mistrust of the kinds of consultation exercises often employed, in which the publics' answers are essentially pre-determined by the nature of the questions being asked. Again, several participants referred to the GM controversy; yet, in an interesting echo of that debate, there were plenty of participants at the other end of the spectrum who saw it as important that the public be informed about and consulted on the risks and benefits of technologies that have already been developed. For example:

> Like any of these production routes, technologies and things like that, you've got to get some level of acceptance … Ultimately consumers, the populace have got to feel assured that what's happening is good … certainly not bad, anyway. (E)

> You need to convince the public that there is some value in these bioenergy crops without detracting from food production, from the value of your agricultural lands. (I)

The range of responses we identified here was almost entirely aligned with the continuum of responses discussed in the previous section regarding the relative 'necessity' of novel GGR proposals. Participants who envisaged a more agenda-setting role for the public tended to be more sceptical, highlighting concerns about justice, democracy and social and environmental risks. Meanwhile, those who envisaged a more consultative role for the public tended to advocate more for GGR, often envisaging its necessity or even inevitability in the years ahead. As such, we found that the responses were not necessarily aligned with participants' discipline or area of expertise.

3. DISCUSSION

3.1 Incumbency

As suggested in the preceding section, much of the underlying discourse and debate over GGR is related to perceptions of incumbency. Although there was much diversity in our participants' attitudes to GGR, attitudes seemed to coalesce around whether or not they felt that climate strategies should aim to work within existing incumbent capitalist systems. There is a question here over whether the primary concern is climate change or the fossil fuel industry, or even capitalism itself;

currently, these tend to be aligned in climate discourse but, if solutions to climate change actually come from within the industry – for instance, by financing GGR through the polluter pays principle – then this discourse becomes contradictory. An interesting corollary to this can be found in work showing that geoengineering solutions may actually be popular with climate sceptics as it seems to align better with 'individualist' and 'hierarchical' worldviews than conventional climate change approaches, which mainly appeal to 'egalitarian' worldviews. In this way, debates around GGR find similarity with earlier debates on sustainable development and ecological modernisation: in both cases, proponents of incumbent systems argue that a sustainable transition is possible by shifting existing industrial society toward a more ecologically focused mode of production, whereas 'deep green' advocates argue for radical transformation away from the capitalist focus on economic growth (see Dryzek 1997). Applying this to the new debate on technological solutions to climate change and the role of climate models, Michael Keary (2016) argues for an approach that 'would not stake the earth on future technological improvements' (24). This is linked to the topic of mitigation deterrence because GGR is seen by many as a potential opt-out, allowing incumbents to avoid taking difficult decisions or actions on climate change.

Within the 'necessity' discourse, radical emissions reductions are seen as being simply too difficult, implying that GGR is needed to avert dangerous climate change. Yet this discourse was critiqued and even rejected by many of our participants on the grounds that there is a difference between a technical and a political challenge. The counter-discourse argues that radical emissions reductions are portrayed as being 'too difficult' by incumbent interests who wish to protect the status quo. Importantly, this suggests that Carbon Capture and Storage (CCS) may provide a useful analogue for thinking about GGR risk and responsibility (see Markusson et al. 2017). Experts' perceptions of CCS have been researched in more depth than GGR, and there is some evidence that CCS may prompt some of the same social and ethical concerns, such as path dependency and mitigation deterrence (Hansson and Bryngelsson 2009; Markusson and Haszeldine 2009). The 'necessity' discourse is also found to be quite strong amongst experts discussing CCS, wherein tackling climate change is seen as being too great a challenge without it.

However, we also noticed a major point of departure: depending on the study, experts' perceptions of CCS often focus on barriers to implementation – in other words, whether we actually *could* implement CCS – whereas the results from our GGR interviews show a crucial ethical and normative element – that is, whether we *should* implement GGR. This is interesting because many GGR proposals necessarily incorporate CCS technology, thus raising the question of whether there is anything particular about negative emissions (as opposed to emissions reduction) that makes it more ethically problematic. Exploration of the particular characteristics of GGR and CCS shows that

ethical differences between them are in fact extremely blurred. Therefore, we suggest that perhaps the very concept of removing GHGs from the atmosphere gives a stronger implication that mankind has failed to adequately challenge unsustainable system dynamics.

In many ways, the ambivalence around certain topics in the preceding section (e.g. the role of climate models and the private sector) is symptomatic of the ambivalence experienced by participants about working within incumbent systems and institutions. Our interviews showed that stakeholders do not necessarily fall into two separate camps, and often even experience ambivalence regarding their own stance. In other words, there is a deep debate occurring – not only between separate people, but within the minds of individuals themselves – over whether technological solutions represent a pragmatic strategy in the face of incumbent system inertia, or whether they simply fail to adequately address unsustainable patterns of production and consumption. Unlike Gannon and Hulme (2018), whose Q-sort study identified a fairly polarised discourse surrounding ocean fertilisation, our interviews revealed that both 'advocacy' and 'critical' discourses (see Anshelm and Hansson 2014) were frequently present within the same stakeholder. Perspectives are thus non-binary, and although there may be outspoken proponents toward each end of the continuum, most of our participants spoke to multiple places on the continuum simultaneously. Cairns and Stirling (2014) find similar nuance in their study, which they relate to the ambiguity of the term 'geoengineering', yet in our interviews, this ambiguity emerged despite discussing three specific GGRs, suggesting that it may go beyond definitional questions, terminological clarity or lack thereof.

This debate is connected to the wider discussion of whether GGR is 'restorative' or 'additive' (Preston 2015); the suspicion over incumbent systems in many ways reflects a deep unease about the concept of GGR as 'restorative' because net anthropogenic forcing is not really seen as being the 'root cause' of climate change. Yet there is tension here with the mitigation deterrence discourse, which might explain some of the ambivalence. There is widespread agreement (both in our interviews and in the surrounding policy and academic literature) that conventional mitigation options such as renewables must take precedence in order to avoid mitigation deterrence; yet large-scale commercial renewables do not really challenge the incumbent system either. Again, the heightened levels of concern about GGR suggest that the concept of removing GHGs creates an impression of failure to challenge unsustainable system dynamics.

3.2 'The Monsanto effect'

It might seem odd to name a paper after a company which, to our knowledge, has little or no involvement in GGR. Yet the Monsanto company was mentioned unprompted by a surprising

number of our participants, and their role in GM crop development may provide an interesting example of *and* lens on the themes of trust and incumbency discussed throughout this paper. The GM controversy offers important lessons for novel technology development in that it acted as an illustration of the importance of extensive upstream public engagement: by the time decision makers read the results of early engagement work, a major public controversy had erupted, with NGOs and some media platforms taking strong anti-GM stances (Grove-White et al. 2000). As a major producer of GM crops, Monsanto became synonymous not only with distrust over the crops themselves but the entire incumbent agro-industrial system. We call this the 'Monsanto effect', whereby one company's involvement in an entirely separate debate (in this case, GM food) taps into deeper narratives and becomes so pervasive that it spills over into a new debate – in this case, GGR.

This analogy could, in theory, be generalised to multiple other topics, not least because this narrative isn't really about Monsanto *per se*. Monsanto simply represents the incumbent system over which there is a lack of trust and a perception of 'misaligned responsibility' – in other words, responsibility for profit motives rather than for the good of society or the environment. Indeed, the results from our interviews were interesting because they revealed a rather fundamental lack of trust in many institutions, particularly those in and of the private sector. This distrust reflects debates around the role of GGRs (particularly BECCS) in IAM scenarios (Anderson and Peters 2016; Vaughan and Gough 2016). Again, the misgivings revealed something deeper than distrust in the modelling process *per se*; rather, the concern was that the very questions being asked in the scientific community are defined by a small group of elites, without participation from those who might be most affected by the outcomes. In a similar vein, Keary (2016) argues that climate models employ technological optimism in order to show us that sustainability and economic growth are compatible, while marginalising discourses that might contradict this. McLaren (2016) suggests that this type of framing actually benefits GGR over SRM because GGR may be more compatible with a neoliberal ideology, wherein climate change can supposedly be tackled using technology and carbon markets, whereas SRM represents a far more disruptive challenge to incumbent systems. The 'promise' of GGRs in climate models thus permits the idea of continuing with the existing regime without having to change it much (Markusson et al. 2018). In this sense, the ambivalence revealed by our stakeholders is reflective of discussions in the literature on climate change, particularly around the notion of 'epistemic justice' in climate decision-making: that is, concern about the ways in which society interprets a particular phenomenon or tackles a particular question (Mabon and Shackley 2015). Thus, even if fair procedures are in place, viewpoints may be marginalised by the way an entire societal discourse treats a question or problem; for example, processes of framing and agenda-setting can determine which knowledge (and whose voices) are rendered admissible (Blue 2015). By

seeking a 'global knowledge consensus' (for instance, through deference to global IAMs), climate change discourse increasingly allows only the most powerful to determine what forms of knowledge are valid, rather than attending to the diversity of cultures and values that generate a diversity of forms of knowledge (Hulme 2010).

These issues of trust mean that more diverse publics need to be involved in decision-making, not just over when or where a technology is implemented, but over the emerging discourse around that technology and the questions that are asked. Amongst our experts, those who envisaged a more active and agenda-setting role for non-experts tended to be more sceptical of GGR, whereas those who outlined a more consultative role tended to be much more advocative. This has important implications for the way in which GGR support mechanisms are designed and appraised, since advocates might be less predisposed to get broader peer communities or publics involved – and yet the literature on public engagement (plus decades of experience) shows us why this might be a mistake (Funtowicz and Ravetz 1995; Grove-White et al. 2000). Equally, we need to be reflective about the motives of those sceptical of GGR who propose a broader role for non-experts: it may be that non-experts are seen as a mechanism by which GGR proposals can be slowed or halted yet, in the current absence of empirical research on public perceptions of these proposals, we cannot simply assume that they will play this role.

3.3 Limitations and areas for further research

It was interesting to note the diversity of viewpoints that emerged from our interviewees. This was partly a reflection of the broad range of opinions we sought to elicit, however, and the fact that – owing to constraints on time and resources – it was only possible to interview seventeen people in total. Interviewing more might have given us a better idea of the extent of viewpoint diversity and the degree of alignment with participants' sectors and disciplines. Further, our purposive/snowball sampling methodology, whilst widely recognised in the literature on expert elicitation, may have biased our findings due to our subjective targeting of participants. Upon reflection, it would also have been useful to interview people from a larger geographical range, including experts from the Global South; although many of our experts voiced with some authority the views of their global organisations and/or partners in Global South areas, their perspectives will still have been rooted in their local or national contexts and experiences (Gannon and Hulme 2018).

The interview results were also limited by the time allotted to each session: in recognition of our participants' busy schedules, we aimed to keep interviews to around one hour each, and there was not always time within the hour to discuss individual GGR proposals in much detail. Our

methodology deliberately sought to allow interviewees to determine the direction of the conversation, with some focusing more on specific technologies and some discussing the concept more generally. However, more time could have been devoted to probing perspectives on BECCS, in particular; for example, exploring in more depth the differences in the types of risk discussed for BECCS as opposed to other GGR proposals (see section 3.1). Nevertheless, our results suggest that there may be something rather fundamental about the way in which these three novel GGRs are envisaged and the way in which they interact with incumbent systems, which is useful to explore as a separate discussion from technology-specific risks.

4. CONCLUSIONS AND RECOMMENDATIONS

This paper has contributed to a growing body of research on Greenhouse Gas Removal for climate change mitigation, exploring stakeholder discourses on three GGR proposals (BECCS, Direct Air Capture and Enhanced Weathering), with a particular focus on the role of these GGRs in future social and political systems. Conceptualising 'informed stakeholders' as a certain type of public whose perspectives are shaped by assumptions and subjectivities just like other publics, we have argued that it is important to engage with such stakeholders whilst remembering that their knowledge should not necessarily be prioritised over other forms or sources of knowledge. We found considerable diversity in opinion amongst our interviewees, with new perspectives emerging with each new person we spoke to and only partial alignment with their specific discipline or sector. From these interviews, we have suggested that CCS can provide a useful analogue for thinking about GGR risk and responsibility; however, we note that expert perspectives on CCS tend to focus on a techno-economic narrative of whether we *could* implement such systems, whereas these GGRs seem to raise more ethical and normative narratives of whether we *should.* The underlying sentiments of our participants suggested that this may be because the concept of negative emissions gives a stronger implication that mankind has failed to adequately challenge unsustainable system dynamics.

Ambivalence emerged about the role of the private sector across the interviews, with participants lacking trust in private companies' motives yet simultaneously acknowledging that their resources may be required. We noticed that the Monsanto company was mentioned by numerous interviewees, despite the fact that they have no current involvement in GGR, which we suggest is an effect of the ways in which Monsanto became synonymous with incumbency, distrust and misaligned responsibility during the GM debate. Consequently, we presented the idea of a 'Monsanto effect', whereby any organisation's involvement in a separate debate taps into deeper narratives and becomes so pervasive that it spills over into an entirely new debate. This effect is illustrative of the way in

which perspectives on GGR seem to be rooted in deep-seated values regarding trust and the role of incumbent systems and interests. GGR appears to be symptomatic of a deep debate, sometimes within the minds of individuals themselves, over whether technological solutions represent a pragmatic strategy in the face of incumbent system inertia, or whether they simply fail to adequately address unsustainable patterns of production and consumption. We thus highlight a particular psychological challenge facing high-tech GGR in that actors may themselves feel conflicted about its desirability. This has significant implications for climate policy, as it suggests that some novel GGRs might lack the kind of support that may be necessary for timely, large-scale deployment. In other words, GGR appears to be failing to garner support that is simultaneously broad (i.e. from a spectrum of actors including policy-makers, NGOs and intermediaries) and deep, in that it aligns with actors' values.

The topics covered in this paper are essentially about four forms of justice: distributive, restorative, procedural and epistemic. Our participants' ambivalence about the role of the private sector, and their concerns about the impact of GGR on land requirements and communities in the Global South, are questions of distributive justice: who gets the burden *of* and who benefits *from* climate change mitigation? Meanwhile, the topic of responsibility raises questions of restorative justice: to what extent will those causing the problem be held responsible for dealing with it? Debates around climate targets and the role of the public involve questions of procedural justice: who gets to decide whether GGRs are 'necessary'? Each of these topics emerged from our analysis, not as discrete headings, but as a tightly interconnected web of overlapping concerns, rooted in deep-seated values regarding the role of incumbent systems and interests and in underlying concerns about the degree to which epistemic justice is maintained in current approaches to developing and assessing climate policy. We thus conclude by recommending that greater attention is paid to the roles of justice and incumbency in the development and deployment of GGR proposals. It can be difficult to be reflexive about the influence of a powerful incumbent narrative when, to some extent, all experts (including the authors of this paper) exist within it; yet, perhaps greater focus on the justice questions raised here can help to provide a counter-balance to the incumbent narrative that speaks of 'necessity' to deploy GGRs at scale. For example, we agree with some of our participants that there needs to be a measured discussion about the primacy of carbon targets in climate strategy, lest we risk drifting toward solutions which may *create* some of the impacts we are trying to avoid. We also recommend that future work continue to build on the efforts of previous research to 'open up' the appraisal of novel technologies to different publics and different framings and definitions of the problem (see for example Bellamy et al. 2013; Bellamy and Lezaun 2017; Pidgeon et al. 2017). Crucially, this means

improving the mechanisms by which diverse perspectives can contribute towards the co-creation of knowledge, decision-making and responsible technology development.

Conflict of Interest Statement: The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Table 1: *Some major GGR proposals (adapted from Olsen 2011).*

Method	**Description**	**Tech readiness**	**Concerns**
Afforestation / reforestation	Planting trees or reforesting previously deforested areas	Already widely implemented	• Land-use conflicts between reforestation and agriculture • Carbon stored in vegetation can easily be released by fire, drought or deforestation
Soil Carbon Sequestration (SCS)	Changing land management and farming practices to increase the carbon content of soil	Ready for implementation	• Soils eventually reach saturation • Vulnerable to disturbance (e.g. later land-use changes) • May increase release of other greenhouse gases from soil
Wetland restoration	Restoring or constructing carbon-dense ecosystems such as wetlands, peatlands and coastal ecosystems.	Already being implemented at small scale	• Increased production of non-CO2 gases such as methane • Relatively limited global sequestration potential • Competition for land
Bioenergy with Carbon Capture and Sequestration (BECCS)	Biomass used as fuel for electricity generation or hydrogen production, with Carbon Capture and Storage (CCS) of the resulting CO2.	All components ready but not yet being used at scale. CCS deployment experiencing delays.	• Fuel vs. food: incentive for biomass production can reduce the availability and increase the cost of food crops • Environmental impacts of intensive growing • Availability and safety of sequestration sites
Biochar	Agricultural and forestry wastes burned through pyrolysis to produce biochar (charcoal), which is sequestered in the soil.	Well understood but not yet widely implemented due to lack of pyrolysis facilities.	• Supply of biomass wastes • Long-term impacts of high biochar applications not yet known

Terrestrial Enhanced Weathering (EW)	Rock weathering processes accelerated by finely crushing and spreading rocks. Rocks weather to produce carbonates, which sink into the deep ocean, sequestering the carbon they contain.	Could technically be implemented now, but not economically feasible. Field trial research into ecosystem impacts is ongoing.	• Requires mining, processing and transportation of large quantities of crushed rock, with high energy use and costs • Uncertainties about impacts on soil pH and vegetation • Possible leaching of heavy metals into soils and crops
Direct Air Capture (DAC)	Industrial processes to extract CO2 from ambient air, with capture and storage (CCS) of the CO2 .	Mainly at laboratory stage. CCS deployment experiencing delays.	• Technically feasible, but not clear if cost effective processes can be developed • Requires large amounts of energy to power the DAC units • Availability and safety of sequestration sites
Ocean Fertilisation	Adding iron, nitrogen or phosphates to ocean water as nutrients to stimulate the growth of phytoplankton that absorb CO2 during photosynthesis.	Research stage. Deployment prohibited under the London Convention.	• Potential disruption of the ocean carbon system • Not as effective as hoped for removing carbon • Generally viewed as extremely high-risk

Table 2: *Details of interviewees*

Alias	**Sector**	**Subject area**
A	Academia	Social sciences
B	Academia	Social sciences
C	Academia	Physical sciences
D	Policy / regulation	Law & social science
E	Private sector	Physical sciences
F	Academia	Engineering
G	Academia	Physical sciences
H	Academia / policy	Physical sciences
I	Academia	Physical sciences
J	Academia	Physical sciences
K	Private sector	Policy
L	Academia	Social sciences
M	NGO	Law & policy
N	Academia	Social sciences
O	NGO	Policy
P	Policy / regulation	Policy
Q	NGO	Policy & social science